

INFORMATION  
ONLY

ROCKY FLATS ENVIRONMENTAL  
TECHNOLOGY SITE  
EMD OPERATING  
PROCEDURES MANUAL  
VOLUME III: GEOTECHNICAL

Manual No.: 5.21000-OPS-GT  
Procedure No.: Table of Contents, Rev 62  
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Effective Date: 02/08/95  
Organization: Environmental Management

THIS IS ONE VOLUME OF A SIX VOLUME SET WHICH INCLUDES:

VOLUME I: FIELD OPERATIONS (FO)  
VOLUME II: GROUNDWATER (GW)  
VOLUME III: GEOTECHNICAL (GT)  
VOLUME IV: SURFACE WATER (SW)  
VOLUME V: ECOLOGY (EE)  
VOLUME VI: AIR (AP)

Procedure No.	Title	Rev. No.	Effective Date
GT.01	Logging Alluvial and Bedrock Material	2	05/12/92
94-DMR-001007	LIMITED SCOPE - Section GT.01 Text and Form GT.1A Modification	2	06/01/94
GT.02	Drilling and Sampling Using Hollow Stem Auger Techniques	2	05/12/92
93-DMR-000955	Form GT.2A Modification	2	01/10/94
93-DMR-000960	QC Sample Collection Modification	2	01/10/94
94-DMR-000382	Approval Process and Sampling Collection Modification	2	03/28/94
94-DMR-000405	Sample Liner Taping Changes	2	03/28/94
94-DMR-000995	LIMITED SCOPE - Section GT.02 Text Modification	2	06/01/94
GT.03	Isolating Bedrock from Alluvium with Grouted Surface Casing	2	05/12/92
93-DMR-000956	Form GT.3A Modification	2	01/10/94
94-DMR-000418	Advanced Notification to the State of Colorado	2	04/22/94
•95-DMR-000088	Haliburton Surface Casing Installation procedure	2	02/08/95
GT.04	Rotary Drilling and Rock Coring	2	05/12/92
93-DMR-000957	FORM GT.4A Modification	2	01/10/94
94-DMR-000419	Advanced Notification to the State of Colorado	2	04/22/94
94-DMR-000935	Procedure Modification to Allow Sonic Drilling Technique Usage	2	06/01/94
GT.05	Plugging and Abandonment of Boreholes	2	05/12/92
93-DMR-000961	Form GT.5A Modification	2	01/10/94

ADMINISTRATIVE

DOCUMENT CLASSIFICATION REVIEW WAIVER  
PER R.B. HOFFMAN, CLASSIFICATION OFFICE  
JUNE 11, 1991

A-SW-001377

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GT.06	Monitoring Wells and Piezometer Installation	2	05/12/92
94-DMR-000801	CO Regulatory Statute Reference Citations and Text Modification	2	06/01/94
94-DMR-000994	LIMITED SCOPE - Section 6 Text Modification	2	06/01/94
94-DMR-002107	TEMPORARY LIMITED SCOPE - IHSS 110 Screen Modifications	2	<b>EXPIRED</b>
94-DMR-002349	LIMITED SCOPE - Installation of Mini Wells	2	12/22/94
GT.07	Logging & Sampling of Test Pits and Trenches	2	05/12/92
94-DMR-000276	Section GT.07 and form Modifications	2	02/28/94
GT.08	4-E42-ER-OPS-GT.08 - Surface Soil Sampling	3	01/25/94
94-DMR-000133	Sampling Modifications	3	02/04/94
94-DMR-000229	Editorial Correction GT.08	3	03/14/94
94-DMR-000857	LIMITED SCOPE - Expansion of Scope of 94-DMR-000133	3	07/19/94
GT.09	Soil Gas Sampling and Field Analysis	2	05/12/92
94-DMR-000431	Calibration Occurrence Clarification	2	04/11/94
94-DMR-001521	Clarification of Soil Gas Procedures	2	09/02/94
94-DMR-002036	TEMPORARY LIMITED SCOPE - Interagency Agreement Air Volocity Measurement Required	2	<b>EXPIRED</b>
GT.10	Borehole Clearing	2	05/12/92
GT.11	Plugging and Abandonment of Wells	2	05/12/92
93-DMR-000962	Form GT.11A Modification	2	01/10/94
94-DMR-000561	Section 11 Modification	2	05/06/94
GT.15	Geophysical Borehole Logging	2	05/12/92
GT.17	Land Surveying	2	05/12/92
94-DMR-000560	Text Modification	2	05/06/94

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GT.18	Surface Geophysical Surveys	2	05/12/92
94-DMR-001997	LIMITED SCOPE - Seismic Refraction Surveys at OU4 for Phase II activities	2	10/27/94
GT.19	Field Gas Chromatographs	2	05/12/92
GT.20	Procedures for Soil Interstitial Water Sampling and Sampler Installation	2	05/12/92
94-DMR-000297	Section GT.20 and form Modifications	2	02/28/94
GT.21	Cone Penetrometer Testing	1	05/12/92
GT.24	Approval Process for Construction Activities on or Near Individual Hazardous Substance Sites (IHSSs)	0	05/12/92

## DOCUMENT MODIFICATION REQUEST (DMR)

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Refer to 1-A01-PPG-001 for Processing Instructions.  
Print or Type All Information (Except Signatures)

1. Date  
January 24, 1995

INFORMATION  
DMR No. 95-DMR-000028

2. Existing Document Number/Revision  
5-21000-OPS-GT.3/Rev.2

3. New Document Number or Document Number if it is to be changed with this Revision N/A

Originator's Name/Phone/Page/Location  
Mark R. Wood/8784/5904/080-641

5. Document Title: Isolating Bedrock from the Alluvium with Grouted Surface Casing

6. Document Type X Procedure  
☐ Other \_\_\_\_\_

7. Document Modification Type (Check only one)

☐ New ☐ Revision X Intent Change ☐ Nonintent Change ☐ Editorial Correction ☐ Cancellation

8. Item	9. Page	10. Step	11. Proposed Modifications
1	5 of 10	5.1.1	First paragraph, first sentence, replace schedule 40 PVC with schedule 80 PVC.
2	6 of 10	5.2	Revise last paragraph of Section 5.2 as follows. Surface casing will be emplaced to a depth that will isolate the upper hydrostratigraphic unit (UHSU) from the lower hydrostratigraphic unit (LHSU). If unweathered claystone is encountered at the base of the UHSU, surface casing will be embedded a minimum of 3 feet into the LHSU. If the core samples indicate siltstone or sandstone immediately below the base of the UHSU, drilling will continue until a minimum of 3 feet of unweathered claystone is encountered, then the surface casing may be installed.
3	6 of 10	5.3	Replace Section 5.3 as follows: <b>5.3 SURFACE CASING INSTALLATION AND SEALING PROCEDURES</b>  Surface casing will be installed by one of the three procedures described in this section. Method 1 is the preferred method for installing surface casing at RFETS because it reduces the waste volume of grout and it can be used in holes of all depths. The project specific field sampling plan can specify which method or defer one of the three methods depending on field conditions encountered and preference of the EG&G project manager or designee.  40 MRW 1/24/95  Method 1 Install surface casing by placing the casing into the borehole, filling the casing with grout and then forcing the grout from within the casing by pushing a rubber plug down the casing thus displacing the grout out through grout ports at the bottom of the casing. Implementing this method is intended to provide a uniform seal from the base of casing to ground surface. Figure GT.3-1 depicts the casing installation described below.  (1) Measure the borehole total depth using a weighted tape measure. Calculate the volume of grout required for the annular space between the casing and the borehole wall. Increase the volume by 10 to 30 percent depending on drilling conditions and diameter of borehole.  (2) Drill or cut three equally spaced 1 inch diameter holes, slots, or triangles (grout ports) into the wall of the casing immediately above the bottom of the casing. The distance between the bottom of the casing and the holes will not exceed the length of the rubber plug.  (3) Lower the surface casing into the borehole through the augers or drill casing.  (4) Remove the augers and pump the calculated grout volume into the surface casing.

12. Justification (Reason for Modification, EJO#, TP#, etc.)

Procedure was not updated after DCN 93.02 expired. The Haliburton procedure presented in section 5.3 should have remained in effect and is an industry proven method for the installation of surface casing.

If modification is for a new procedure or a revision, list concurring disciplines in Block 13, and enter N/A in Blocks 14 and 15. If modification is for any type of change or a cancellation, organizations are listed in Block 13, then Concurror prints, and signs in Block 14, and dates in Block 15.

13. Organization	14. Print and Sign (if applicable)	15. Date (if applicable)
EQS	<i>[Signature]</i>	1-25-95
SME	<i>[Signature]</i>	1-24-95
GROUP 1	A. L. Paine	1-25-95
HAOU/DRO	B. A. Peterson	1/25/95
OSG7/Chow	<i>[Signature]</i> / GC Mast	1/25/95
EOM	<i>[Signature]</i> / M. L. Brown	1/26/95
SPD	David A. King Jr. / SP. Ketch	1/30/95

16. Originator's Supervisor (print/sign/date)  
Ed Mast / *[Signature]* 1/24/95

No training Required

17. Assigned SME/Phone/Page/Location  
Tim Lovseth/8706/5134/080

18. Cost Center 3102

19. Charge Number 98647900

20. Requested Completion Date  
January 27, 1995

21. Effective Date  
2/8/95

22. Accelerated Review?  
Yes ☐ No ☒

23. ORC Review Not Required

Feb. 17 man / 1/30/95

24. Responsible Manager (print/sign/date)  
Ed Mast / *[Signature]* 1/24/95

REVIEWED FOR CLASSIFICATION/UCNI

BY NA  
DATE NA

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25.

DMR. No. 95-DMR-000088

3. Document Number/Revision 00-OPS-GT.3/Rev.2			3. Document Title: Isolating Bedrock from the Alluvium with Grouted Surface Casing		
8. Item	9. Page	10. Step	11. Proposed Modifications		
			<p>(5) Place a rubber or equivalent plug, intended for displacing the grout from within the surface casing, inside the surface casing and force it down to within 0.25 to 0.5 foot of the bottom of the surface casing using drill rods or water pressure. Add RFETS potable water to the inside of the casing as the plug is being forced down. The water will aid in equalizing the pressure of the grout on the plug until the grout has set. After grout has been observed at ground level on the outside of the surface casing, the depth of the plug will be checked with the tape measure.</p> <p>(6) Place a protective cover over the top of the surface casing and allow the grout to set for at least 24 hours.</p> <p>(7) After the grout has set, drill out the grout and plug to a depth of 2 to 3 feet from the bottom of the surface casing and remove or change out the fluid from the borehole by air lift methods or bailing.</p> <p>Method 2 Method 2 is the same as Method 1 with the following modifications. The surface casing may be installed by filling the borehole with grout as the augers are removed, placing the casing into the grout filled borehole after auger removal, and then forcing the grout from within the casing using a rubber plug.</p> <p>Method 3 Place surface casing with threaded PVC cap or rubber plug on bottom end into borehole. Fill surface casing with potable water to ensure positive pressure. Following installation of surface casing in the borehole, a 2 to 3 foot thick bentonite seal consisting of 1/4 inch bentonite pellets will be placed at the bottom of the annulus surrounding the surface casing. If the borehole annulus does not contain water, potable water will be added to hydrate the pellets prior to grouting. Following the installation of the bentonite seal the grout seal will be emplaced in the annular space between the augers or drill casing and the surface casing. Upon removal of each section of auger or drill casing, additional grout will be added to the annulus. The grout will be emplaced by means of a tremie pipe. The grout will be allowed to set for 24 hours before advancing the borehole.</p>		
12. Justification (Reason for Modification, EJO#, TP#, etc.)					

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1A, 2-3A	04/22/94	94-DMR-000418
3, 9-10	01/10/94	93-DMR-000956
5, 6, 8-9	02/08/95	95-DMR-000088
Form GT.3	01/10/94	93-DMR-000957

TOTAL NUMBER OF PAGES (including forms): 17

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- Pre-approved water from a potable source (see SOP FO.3, General Equipment Decontamination)
- Plastic Sheeting

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### 5.1.1 Casing Requirements

Surface casing will consist of new schedule 80 poly-vinyl chloride (PVC) or steel well casing. PVC casing will be used for nominal casing diameters of 6 inches or less. Larger casings will be steel. Joints will be water-tight threaded couplings made without welds, solvents or lubricants. The casing will be embedded into the top of bedrock and extend to approximately 1 foot above the ground surface. Casing centralizers will be attached to the casing to allow uniform grouting. At least 2 centralizers will be required, one within 5 feet of the bottom and the other within 5 feet of the top of the casing. All surface casing will be free of foreign material and will be decontaminated according to SOP FO.3, General Equipment Decontamination. Decontaminated casing will be stored in plastic sheeting or kept on clean racks prior to use.

### 5.1.2 Grout Requirements

The grout mixture will consist of a cement and reduced pH bentonite grout (American Colloid Pure Gold or approved equivalent) mixed according to the manufacturer's recommendations. The mixture will contain 5 to 10 percent bentonite by weight and have a minimum density of 13 to 15 pounds per gallon after mixing. The density will be measured using a mud balance.

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methods, their use may be outlined in a project-specific work plan. Drilling equipment including the rig, augers, drill rods, and samplers will be decontaminated according to SOP FO.3, General Equipment Decontamination, and SOP FO.4, Heavy Equipment Decontamination. The borehole will be of sufficient diameter to allow 2 inches of grout between the casing and the borehole. Each borehole location will be cleared according to SOP GT.10, Borehole Clearing, before drilling.

The embedment of casing into the bedrock will be a minimum of 3 to 5 feet into the weathered bedrock. However, the intent is to place the bottom of the casing approximately 3 feet below the interface describing a substantial reduction in hydraulic conductivity. If the uppermost weathered bedrock is highly weathered and/or fractured, this embedment depth will be adjusted downward. Based on field experience at RFP, casing may be emplaced to depths of up to 60 feet in highly weathered or fractured bedrock to ensure a good seal. When very shallow, bedrock boreholes are augered to total depth in uncontaminated areas, surface casing will not be used. Instead, the borehole will be drilled and grouted in one day.

Surface casing will be emplaced to a depth that will isolate the upper hydrostratigraphic unit (UHSU) from the lower hydrostratigraphic unit (LHSU). If unweathered claystone is encountered at the base of the UHSU, surface casing will be embedded a minimum of 3 feet into the LHSU. If the core samples indicate siltstone or sandstone immediately below the base of the UHSU, drilling will continue until a minimum of 3 feet of unweathered claystone is encountered, then the surface casing may be installed.

### 5.3 SURFACE CASING INSTALLATION AND SEALING PROCEDURES

Surface casing will be installed by one of the three procedures described in this section. Method 1 is the preferred method for installing surface casing at RFETS because it reduces the waste volume of grout and it can be used in holes of all depths. The project specific field sampling plan can specify which method or defer to one of the three methods depending on field conditions encountered and preference of the EG&G project manager or designee.



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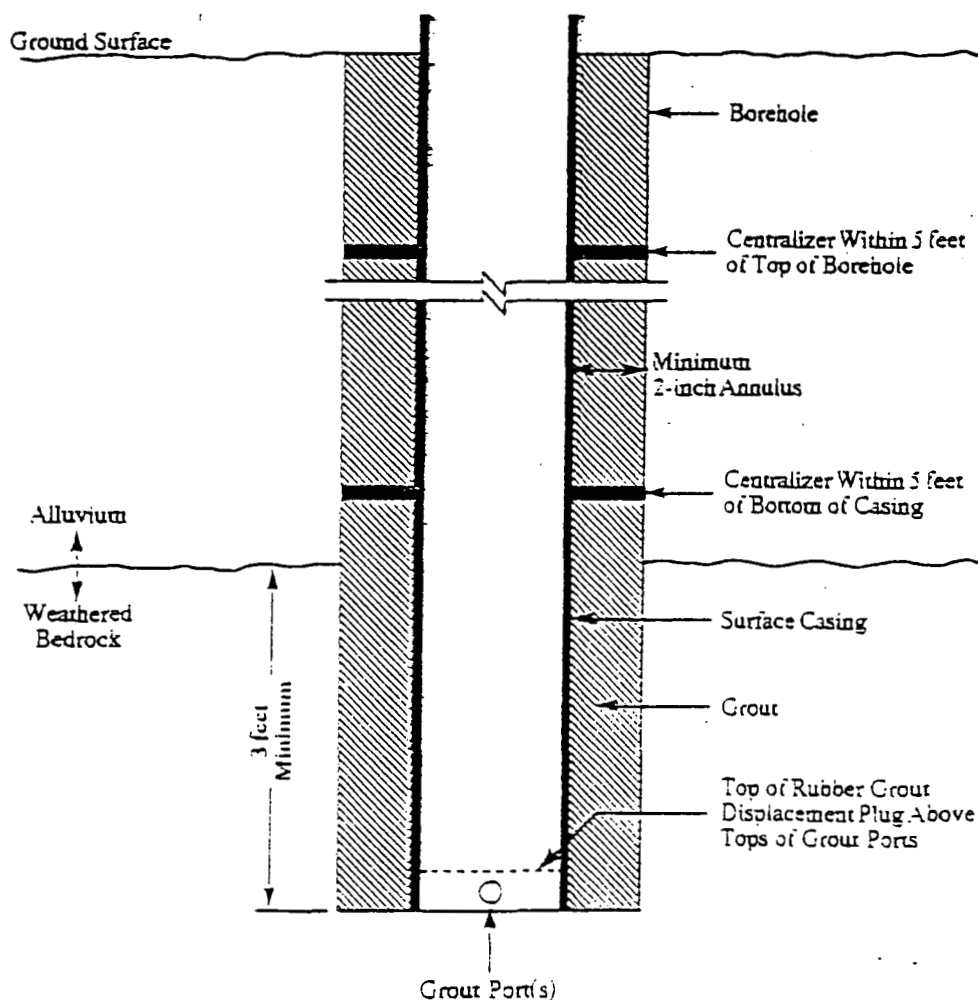
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FIGURE GT.3-1 SCHEMATIC DIAGRAM OF GROUTED SURFACE CASING



Not To Scale

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### Method 1

Install surface casing by placing the casing into the borehole, filling the casing with grout and then forcing the grout from within the casing by pushing a rubber plug down the casing thus displacing the grout out through grout ports at the bottom of the casing. Implementing this method is intended to provide a uniform seal from the base of casing to ground surface. Figure GT.3-1 depicts the casing installation described below.

- (1) Measure the borehole total depth using a weighted tape measure. Calculate the volume of grout required for the annular space between the casing and the borehole wall. Increase the volume by 10 to 30 percent depending on drilling conditions and diameter of borehole.
- (2) Drill or cut three equally spaced 1 inch diameter holes, slots, or triangles (grout ports) into the wall of the casing immediately above the bottom of the casing. The distance between the bottom of the casing and the holes will not exceed the length of the rubber plug.
- (3) Lower the surface casing into the borehole through the augers or drill casing.
- (4) Remove the augers and pump the calculated grout volume into the surface casing.
- (5) Place a rubber or equivalent plug, intended for displacing the grout from within the surface casing, inside the surface casing and force it down to within 0.25 to 0.5 foot of the bottom of the surface casing using drill rods or water pressure. Add RFETS potable water to the inside of the casing as the plug is being forced down. The water will aid in equalizing the pressure of the grout on the plug until the grout has set. After grout has been observed at ground level on the outside of the surface casing, the depth of the plug will be checked with the tape measure.

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- (6) Place a protective cover over the top of the surface casing and allow the grout to set for at least 24 hours.
- (7) After the grout has set, drill out the grout and plug to a depth of 2 to 3 feet from the bottom of the surface casing and remove or change out the fluid from the borehole by air lift methods or bailing.

### Method 2

Method 2 is the same as Method 1 with the following modifications. The surface casing may be installed by filling the borehole with grout as the augers are removed, placing the casing into the grout filled borehole after auger removal, and then forcing the grout from within the casing using a rubber plug.

### Method 3

Place surface casing with threaded PVC cap or rubber plug on bottom end into borehole. Fill surface casing with potable water to ensure positive pressure. Following installation of surface casing in the borehole, a 2 to 3 foot thick bentonite seal consisting of 1/4 inch bentonite pellets will be placed at the bottom of the annulus surrounding the surface casing. If the borehole annulus does not contain water, potable water will be added to hydrate the pellets prior to grouting. Following the installation of the bentonite seal the grout seal will be emplaced in the annular space between the augers or drill casing and the surface casing. Upon removal of each section of auger or drill casing, additional grout will be added to the annulus. The grout will be emplaced by means of a tremie pipe. The grout will be allowed to set for 24 hours before advancing the borehole.

## 6.0 DOCUMENTATION

All information required by this SOP will be documented on the Borehole Log Form (Form GT.1A) and on the ~~Surface Casing Installation Field Activities Report form (Form GT.3A)~~ Daily Field Drilling Activities Report Form (Form GT.2A). Form GT.32A will be filled out for each day of drilling at a given borehole location; and, in situations where more than one boring is drilled and completed per day per drill rig, at least one form will be completed per boring. ~~The borehole log will include information on subsurface material classification and lithology.~~ The Daily Field Drilling

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Activities Report will include the following information and have space for comments and documentation of general observations:

- Project name and borehole identification
- Subcontractor
- Location code
- Date
- Weather conditions
- Driller and drilling company
- Geologist and other crew members
- Equipment descriptions (rig, etc.)
- Borehole depth and diameter

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- ~~Water level~~
- Sample number
- ~~Depth to bedrock~~
- OC Code
- ~~Casing diameter and depth~~
- Time
- ~~Type of casing (schedule, wall thickness, grade, etc.)~~
- OVM and RAD readings
- ~~Casing stick up (measured height above ground level)~~
- ~~Centralizer types and depths~~
- ~~Quantity and composition of grout (including cement/grout mix ratio and weight in lb/gallon)~~
- ~~Joint/coupling description~~
- End-of-day status
- Chronological record of activities

The above information shall be entered into the field data capture program (Datacap) (see procedure FO.14, Field Data Management).

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